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REVIEW AND SYNTHESIS OF RESEARCH IN TECHNICAL EDUCATION.

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MATERIALS FROM LIBRARIES, INDIVIDUAL RESEARCHERS, UNIVERSITIES, AND STATE AND FEDERAL AGENCIES WERE REVIEWED IN ORDER TO PRESENT A DEVELOPMENTAL PICTURE OF TECHNICAL EDUCATION. MOST OF THE 284 ITEMS WERE PUBLISHED IN 1961-66. EARLIER ONES WERE INCLUDED IF THEY PROVIDED A BASIS FOR TRENDS OR LATER ACTIVITIES. TOPICS COVERED ARE -- (1) PHILOSOPHY AND OBJECTIVES, (2) MANPOWER NEEDS AND EMPLOYMENT OPPORTUNITIES, (3) CURRICULUM DEVELOPMENT, (4) EDUCATIONAL PROGRAMS, (5) INSTRUCTIONAL MATERIALS AND DEVICES, (6) LEARNING PROCESSES AND TEACHING METHODS, (7) STUDENT PERSONNEL SERVICES, (8) FACILITIES AND EQUIPMENT, (9) TEACHER EDUCATION, (10) ADMINISTRATION AND SUPERVISION, (11) EVALUATION, AND (12) RESEARCH. IT WAS CONCLUDED THAT -- (1) MUCH OF THE RESEARCH REPORTED IS "ACTION TYPE" RESEARCH, (2) QUESTIONNAIRES OR OPINIONNAIRES WERE FREQUENTLY USED, AND (3) USE OF THE EXPERIMENTAL METHOD WAS PRACTICALLY NONEXISTENT. HIGH QUALITY RESEARCH WAS RECOMMENDED IN THE AREAS OF -- (1) INSTRUCTIONAL MATERIALS AND DEVICES, (2) LEARNING PROCESSES AND TEACHING METHODS, (3) FACILITIES AND EQUIPMENT, (4) TEACHER EDUCATION, (5) ADMINISTRATION AND SUPERVISION, AND (6) RESEARCH. (EM)

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# Review and Synthesis of Research in

# *TECHNICAL EDUCATION*

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The Center for Vocational and Technical Education has been established as an independent unit on The Ohio State University campus with a grant from the Division of Adult and Vocational Research, U. S. Office of Education. It serves a catalytic role in establishing a consortium to focus on relevant problems in vocational and technical education. The Center is comprehensive in its commitment and responsibility, multidisciplinary in its approach, and interinstitutional in its program.

The major objectives of The Center follow:

1. To provide continuing reappraisal of the role and function of vocational and technical education in our democratic society;

2. To stimulate and strengthen state, regional, and national programs of applied research and development directed toward the solution of pressing problems in vocational and technical education;

3. To encourage the development of research to improve vocational and technical education in institutions of higher education and other appropriate settings;

4. To conduct research studies directed toward the development of new knowledge and new applications of existing knowledge in vocational and technical education;

5. To upgrade vocational education leadership (state supervisors, teacher educators, research specialists, and others) through an advanced study and in-service education program;

6. To provide a national information retrieval, storage, and dissemination system for vocational and technical education linked with the Educational Research Information Center located in the U. S. Office of Education;

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# REVIEW AND SYNTHESIS OF RESEARCH IN TECHNICAL EDUCATION

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August 1966

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## INTRODUCTION

In keeping with The Center's responsibility for stimulating and facilitating research in vocational and technical education and its commitments to information retrieval and dissemination, this Review and Synthesis of Research in Technical Education has been developed. The stimulus for this paper evolved from the recognition of need for establishing a base or "benchmark" for current research efforts and for the national information retrieval and dissemination system being developed by The Center and linked to the Educational Research Information Center in the U.S. Office of Education.

This review paper should aid researchers and practitioners in assessing the current state of the art in research for the field of technical education. Further, it should assist in identifying voids in our present research framework and help "sharpen" future studies, both in terms of their substantive focus and methodological approaches. It is logical to assume that this compact review should also assist practitioners in accelerating the applications of research findings to current practice in vocational and technical education programs.

It is recognized that since the ERIC network and its information retrieval and dissemination system was not yet operative when this paper was prepared, the review is subject to gaps and that, in the main, the paper does not reflect the rapidly evolving findings

generated by funds available through Section 4(c) of PL 88-210. Admittedly, the author had problems in securing all available material, but nevertheless, in our judgment, he has done a splendid job of "pulling together" the significant research in the area.

This paper is one of seven published by The Center dealing with research in a substantive area of vocational and technical education. Other research review papers include: Business and Office Education; Distributive Education; Home Economics Education; Industrial Arts Education; Trade and Industrial Education; Agricultural Education.

Through The Center and the ERIC Clearinghouse for Vocational and Technical Education, it is anticipated that in the immediate future, other research review and synthesis papers will be developed to assist the profession in assessing an updated "state of the art" and of the potential impact of research on educational practice.

We are indebted to Milton E. Larson for his scholarship and efforts in providing the profession with this new benchmark and perspective on research in technical education. Recognition should be given to Dr. Ralph C. Wenrich, Professor and Head, Vocational Education and Practical Arts, School of Education, University of Michigan, Ann Arbor, Michigan, for his critical review and helpful suggestions for refining the manuscript prior to publication. Acknowledgment is also due Dr. Virgil E. Christensen, of The Center staff, for coordinating the work of the several authors.

Final acknowledgment is given to Dr. A. J. Miller, Specialist in Technical Education, at The Center, for his review and assistance in the development of this publication.

We solicit the suggestions and comments of the profession for improving these publications.

Robert E. Taylor
Director

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## PREFACE

Technical education is a comparatively new addition to the total field of occupational education. However, the rapidly changing complexion of technology, science, industry, and education has focused a great deal of attention on the technician as a "key" person filling the gap which has been gradually widening between the engineer and scientist on the one hand and the skilled tradesman on the other.

Since technical education is a relatively new field, the amount of significant, sophisticated research is quite limited. However, much helpful information for research is contained in reports, conference summaries, articles, and other publications. To add to the utility of this paper, selected materials of this nature have been included where a definite contribution to known knowledge of "the state of the arts" in technical education has been enhanced.

The materials reviewed have been gathered from library sources, from individuals involved in research activities, from chairmen of departments of universities having completed such research, from state directors and supervisors of technical education, and from federal agencies and departments engaged in technical education either directly or indirectly.

Every effort has been made to include in this report significant research findings resulting from studies by individuals, organizations, and units of government as well as recognition of

the contribution to the field of knowledge of support information contained in organizational and governmental reports, prepared releases, and other materials which become vital for individuals planning research or expanding the scope of technical education.

In making this review, several studies with titles denoting vocational education, industrial education, and even, in some cases, industrial arts were found upon careful study to contain some very significant findings specifically identified with technical education. Where these studies made an important contribution to this field they have been included in order that the true "state of the arts" may be most accurately reflected.

Essential limitations have been imposed to make this digest more effective. First, studies not within the current five-year period have been omitted unless highly significant to show trends and/or provide the basis for later research and developmental activities. Second, studies that did not contain useful methodology or reveal techniques for systematic attack upon identified categories of problems were not included in this digest. Third, studies and reports were omitted that contained little information which enhanced the knowledge of technical education from such points of view as stage of development of the field, commonly accepted principles, evolving theories, or current trends. Fourth, promotional literature, catalogs of educational institution and similar materials of public information have in the main been excluded. Fifth, census data has been omitted but several manpower reports included do provide some of this type of information.

The structure of the topical organization is provided in the Table of Contents.

To all who contributed materials for review or assisted in any way the author wishes to express his appreciation.

Milton E. Larson

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## PHILOSOPHY AND OBJECTIVES

The philosophy and objectives of technical education gradually emerged during the 20th century. Review of the literature of technical, vocational, and industrial education revealed a gradually developing consensus of the purpose of technical education. Changing industrial technology with greater emphasis on automation and instrumentation has provided additional impetus for clarification of early concepts, objectives, and philosophies.

### Emerging Concepts of Technical Education

The "genesis for development of the technical institute movement" was provided by an early study by the Society for the Promotion of Engineering Education (Wickenden and Spahr, 1931).

Two significant reports contained findings of studies and reflections of outstanding pioneers in the technical education field. In one case (Federal Security Agency, 1944), a nation-wide consulting committee was appointed to study the problem of the technician. Surveys were made of 22 industries by contacting plants identified as employing technicians. The summary of this report contained identified objectives, content, policies, and practices indicative of technician educational programs of that area. The second (Ward, 1947) concentrated on terminal education in the junior college stressing the need for expanded opportunities for students not planning to complete a

four-year college program. Emphasis was placed upon the process of careful analysis of needs of the community with constant reappraisal of occupational trends; integration of occupational training with general education; and increased value placed on occupational competency. The recognition by military leaders (Oncken, 1948) as well as industrial leaders of the need for better educated technical personnel hastened and strengthened technician education.

Technical education in addition to other occupational education functions was discussed in detail (Bogue, 1950) providing a foundation for an evolving philosophy and pattern of realistic objectives. Recognition of a national need for expanded education to serve the needs of industry (National Manpower Council, 1954) was consolidated with expressions of philosophy and suggestions of objectives in a publication resulting from a study supported by the Ford Foundation established at Columbia University to study significant manpower problems and better utilization of the country's human resources. The place of the technician as a member of the engineering team was discussed (Coleman, 1956; Armsby, 1955; Cummings, 1957; American Society for Engineering Education, 1958) from the viewpoint of contributions, duties, and qualifications. A good description of the philosophy, methods and procedures of technical education (Krauss, 1959; Michael, 1959; Emerson, 1959) was given as practiced in the community colleges and technical institutes.

Three comprehensive studies provided considerable refinement of the philosophy and objectives of technician education of the 1950's. A survey of all phases of vocational-technical education in Oregon (Flesher, 1958) provided an overview of occupational need, educational

status, and trends in technical education. A concentrated study of the engineering technician (Henninger, 1959) was promoted by the Technical Institute Division of the American Society for Engineering Education. Members of the study committee visited 96 educational institutions in 39 states and 140 industrial enterprises in 25 states. Comprehensive questionnaires were also mailed to chief administrative officers of all institutions identified as providing technical education. In an evaluation of the contribution of technical education to the needs of industry (California State Department of Education, 1959), members of a study committee visited 41 California junior colleges and eight technical institutes and technical high schools. Analysis of the curriculum and study of the philosophy and practices resulted in a guideline for planning, operating, and evaluating technical education programs.

A book by two authors (Smith and Lipsett, 1959) provided an excellent review of the historical development, curricula, students, staff, and prevalent administrative practices of technical institutes in the United States. Illustrative of the leadership of a State Department (Michigan State Department of Public Instruction, 1959) was a descriptive bulletin of technician training describing the role of the technician, needs of industry, guidance activities, and training programs for technical education. In two other references (Thornton, 1960; Medsker, 1960), studies and appraisals of technical education in the junior colleges were indicated with the philosophy of technical education given considerable attention. A paper (Dobrovolny, 1960) given at a meeting of the Technical Drawing Association presented the historical development of technical institute education with several

references to objectives, philosophy, and programs for the education of technicians.

## Philosophy and Objectives for a Changing World of Work

Several implications for technical education were contained in a challenging document (U.S. Office of Education, 1961c) in which emphasis was placed on the shortage of highly skilled technicians, the increasing need for these technicians, and 14 major objectives of technician training.

The Report of the Panel of Consultants on Vocational Education (Education for a Changing World of Work, 1963) stressed the serious problems, under-employment and unemployment and the lack of quantity and quality in vocational-technical education, demanding immediate attention. In (Technical Training in the United States, Appendix I, 1963) an addition to the Report of the Panel of Consultants, the consultant for technical education elaborated on the philosophy and objectives of technical education viewing the needs of industry, the needs of students for technical education, the institutions offering technical education, and the changing nature of technology from the point of view of total effort demanded of our society and the federal, state, and local governments to achieve the essential goals.

An assessment of the place of occupational education within education as a whole and within a new technological economy was conducted by the American Council on Education (Venn, 1964) concerning the new relationship between man, his education, and his work. In this study of vocational and technical education, the committee recommended the establishment of a national research and planning

body whose sole purpose would be that of translating available information into priorities for the nation's vocational and technical education effort. This assessment is rich in philosophy and sound objectives for technical education, recognizing that technological change will continue as a master of all or as a servant for all.

To investigate the feasibility of launching a program aimed at improving the effectiveness and recasting the pattern of occupational and vocational-technical education was the goal of a high-level planning conference (Frank, 1965a) held at the Massachusetts Institute of Technology. The considerations of the planning conference dealt with vocational education over a continuum from that for the craftsman to that for the technician. Elements of philosophy as well as of practice were considered. An outgrowth of this planning conference was a comprehensive summer study of occupational, vocational, and technical education (Frank, 1965b) dedicated to generating plans to initiate new educational patterns for attaining occupational, vocational, and technical goals. About 60 leaders of vocational and technical education met over a six-to-eight week period to generate fresh, untraditional, and uninhibited ideas for vocational and technical education. New concepts of philosophy concerned patterns of learning, "clinical" education, and the status problem.

A regional attempt to solve dominant issues and problems of higher education and technical education (Technical-Vocational Education and the Community College, 1964) is illustrated by the concerns of educators of the southern states.

Strong elements of philosophy for technical education were evident in three state reports (North Carolina State Board of

Education, 1963a; South Carolina State Committee for Technical Education, 1961; Washington State Board for Vocational Education, 1964).

The elements of today's philosophy and objectives of technical education are contained in several parts of two recent yearbooks (Technician Education Yearbook, 1963; Technician Education Yearbook, 1965).

The important issues of vocational-technical education as well as the total objectives and philosophy are realistically treated in three articles (Leonard, 1963; Feirer, 1964; Sarafian, 1964).

In a study, "Occupational Self-Images of Teachers" (Nelson, 1962), the researcher sought to assess the self-images that teachers held in relation to their work situation. Self-image of teachers in the specialist role of instructor of technicians seems worthy of further study.

A paper, "Improving Vocational and Technical Education" (Feldman, 1966), illustrated deep concerns for the crisis conditions in vocational-technical education. Re-evaluation of philosophy and objectives were implied, with recommendations for extension of vocational education from the elementary school to the 14th grade, redefining of area schools, strengthening of counseling, expansion of work-study, and curriculum coordination at the state level.

Additional research in this area would be helpful.

## MANPOWER NEEDS AND EMPLOYMENT OPPORTUNITIES

Studies in this field are grouped according to scope: national, state, or local. A large number of studies have been made relative to

manpower needs. Many bulletins and booklets utilized in a secondary manner the findings of research together with reports of departments providing a comprehensive treatment of this important element in planning for technical education.

Federal Studies and Reports

The Report of the Commission on Human Resources and Advanced Training (Wolfle, 1954) has been identified as a classic study of scientific, technical, and managerial manpower in the United States.

At a meeting called by the Office of Education, 20 top vocational educators participated in a week-long conference to explore and develop ways of promoting training programs to increase the supply of technicians (U.S. Office of Education, 1957).

Two excellent studies of present employment and long-range demands for technical manpower were made for the National Science Foundation. One study (Bureau of Labor Statistics, 1960) used a stratified random sample of companies drawn from industrial firms involving 10,500 cases. This study established the fact that industry in 1960 used 73 technicians for each 100 scientists and engineers. Another study (Bureau of Labor Statistics, 1961b) has often been considered the best single source of information on long-range projections of technical manpower. The study was undertaken to develop a systematic methodology for the long-range project of demand for scientific and technical personnel through separate analyses and projections for each segment of the economy. The report describes the method developed and presents projections to 1970.

Manpower needs in the field of atomic energy was the subject of two studies in 1961. In one (Bureau of Labor Statistics, 1961a), the

work of technical personnel was thoroughly treated; whereas, in the other (Bureau of Employment Security, 1961a), the educational requirements and job demands for technicians was given in detail.

The problem of youth employment and unemployment with implications for technical education was studied in a recent survey (President's Committee on Youth Employment, 1963) which recommended a new and vital approach to vocational-technical education. Offering training opportunities to the 21 million non-college graduates was a recommendation of the President's Panel of Consultants (Education for a Changing World of Work, 1963). This study emphasized that by 1970 the American labor force will total 100 million people, with 26 million young workers entering the labor force during the decade 1960-70. Data of the numbers of technicians in various industries and similar manpower information were related to opportunities for education in a companion volume (Technical Training in the United States; Appendix I, 1963).

A stratified sampling mail study for the National Science Foundation (Bureau of Labor Statistics, 1964) resulted in a 90 per cent return of approximately 14,200 establishments drawn from individual classes of industrial firms. Findings revealed that approximately half of all technicians were employed in four major industry groups: services, electrical equipment, machinery, and transportation equipment.

A case study research approach coupled with forecasting suggested that technical personnel will increase by 50 per cent in the communications equipment industry by 1970 (C. P. Smith, 1964a).

The employment outlook and trends for technicians was published (Veterans Administration, 1958) as a guide to prospective technicians.

Two other publications providing employment outlook information (Bureau of Labor Statistics, 1962; Manpower, Challenge of the 1960's, 1961) emphasized the educational requirements as well as the nature of technical occupations.

Careers for women as technicians (U.S. Department of Labor, 1961; The Role of Women in Engineering Technology, 1962) identified opportunities for qualified women in industry.

Annually a comprehensive report is prepared for The President's message to Congress on manpower (Manpower Report of the President, 1963; Manpower Report of the President, 1964) giving requirements, resources, utilization and training needs. Highlights of the report (Office of Manpower, Automation and Training, 1963) summarized The President's statements relative to unemployment and changes in employment.

The implications of automation for employment was the topic of a conference at which 16 papers were presented by representatives of government, management, labor, and education (Manpower Implications of Automation, 1965).

The scope of MDTA programs in 1964 encompassed 110,000 who completed training with 74 per cent placements (Wirtz, 1966). Approximately 10 per cent were employed in technical occupations.

A detailed picture of manpower needs in the field of technical education has been compiled from various sources into single volumes which also reflect the supply as well as the demand of manpower (Technician Education Yearbook, 1963; Technician Education Yearbook, 1965).

State Studies

Two dissertation studies focused on employment opportunities and training needs. Both (Prater, 1962; Wooldridge, 1961) compared the probable supply of and demand for technicians from 1960 through 1970. Projections were made from available data.

A researcher (Bearden, 1959) reported the technician requirements in principal industrial areas of Texas upon data gathered by interviewing representatives of 218 selected industries in the state. Another Texas study (Engineering Extension Service, 1959) reported a state-wide survey of technical occupations.

Five states reported state-wide studies of technical education under the auspices of the State Department of Education. One state (Kansas State Board for Vocational Education, 1959) reported the utilization of technicians and their education and training needs. Another state (California State Department of Education, 1959) examined specifically the contributions being made by the junior colleges to the training of students for employment in technical occupations. Visitations, conferences, analysis of curriculums, and review of suggestions by junior college administrators constituted the procedures employed. An outstanding study (Vocational and Technical Education in Illinois - Tomorrow's Challenge, 1960) followed a procedure of continuous weekly seminars, careful analysis of census and other available data, supplemented by intensive surveys in selected junior colleges, technical institutes, and area vocational high schools in several states. To obtain an over-all view of the types of technicians employed and the present and expected future needs, the Connecticut State Board of Education conducted a survey

Righthand, 1964). A survey instrument design for personal interviews was utilized in the study based on the responses of representatives of selected manufacturing and mechanical establishments within the state. An intensive state study in Florida (State Department of Education, 1965) began with the analysis of available data of population growth and distribution, factual presentations of the existing programs, and data showing the needs for trained personnel in the technical fields. This was followed by projection of programs at various educational levels coupled with inventory and evaluation of existing programs. Analysis of financial support, study of patterns of organization and applications of criteria for facilities and location were supplemented by a questionnaire directed to key individuals in centers and junior colleges concerning technical education.

Two excellent studies were reported from New York State. An earlier study (New York State Department of Labor, 1960) focused on manpower and technological changes within the state. One of the most complete studies (Pearce, 1964) provided a broad picture of technical manpower in New York State. This survey was planned and developed with the cooperation of the Division of Industrial Education, the Dean for Two-Year Colleges, and the State Department of Labor. A technique of stratified random sampling was employed. Survey data were derived from a sample of 17,414 establishments constituting 50.4 per cent of the total employment of all businesses in the state. The focus of the study was technical manpower with attention given to both high school and post-high school technical education.

Two manpower studies (Employment Security Commission of North Carolina, 1962; Employment Security Commission of North Carolina,

1962b) reflected the interest of this state in industrial and commercial development and technician education.

Two labor availability surveys suggested the procedures used by a southern state (South Carolina State Committee for Technical Education, 1964a; South Carolina State Committee for Technical Education, 1964b) in making a determination of the need for technical education training facilities in order to adequately meet industries' demands for technical manpower.

A private survey by mail (Gallup and Robinson, Inc., 1964) was conducted for the New Jersey Council for Research and Development to ascertain manpower needs and resources in New Jersey in the technical field. A total of 183 completed questionnaires, 27 per cent of the total, was obtained. In response to one of the questions, 123 companies indicated that sub-professionals with prior training in college were generally most satisfactory. The small percentage of response prohibited generalizing responses to the total industrial population of the state.

Community Studies

A sampling study of technician needs and training facilities was made in the Benton Harbor-Saint Joseph area of Michigan (Brandon, 1958). A Diversified Industrial Survey Form was developed as an interview aid. This was employed by a survey team while interviewing approximately 50 industrial leaders.

Another researcher (Littrell, 1958) sought to determine the employment requirements and opportunities for women as technicians in the St. Louis area. In a well-designed dissertation study, 431 establishments having more than 100 employees each were contacted. Later,

persons familiar with employment requirements and opportunities for technicians were interviewed in 67 establishments employing women technicians. In a similarly structured study (Hinrichs, 1964), the need for technical education in the New Orleans area was examined. Two excellent additional "spot surveys" (Syracuse Board of Education, 1960; Philadelphia Bureau of Employment Security, 1962) concentrated on the need for technicians in highly industrialized metropolitan areas.

The need for both technicians and skilled craftsmen was given as the purpose of another community survey (Board of Education of the Vocational Schools in the County of Middlesex, 1960). The report included data concerning industrial and economic aspects as well as training opportunities, school enrollments, and employment opportunities.

## CURRICULUM DEVELOPMENT

Curriculum development has received considerable attention. While much has been written about curriculum development, content, and analysis, few significantly different curriculum innovations were indicated by the available research.

### Curriculum Analysis

Two aids were frequently used in the planning and developing of technical education curricula (The American Society for Engineering Education, 1962; Occupational Criteria and Preparatory Curriculum Patterns in Technical Education Programs, 1962). The first resulted from a year-long study of engineering technology by a committee

interested in technician education. The second was developed as an aid for program development under Title VIII of the National Defense Education Act. Both suggested curriculum breakdowns into course areas with the semester-hour analysis provided.

Recently at least two extensive research studies were devoted to the identification of a common core for several technician curricula. The researcher (Schill, 1965), in one project, sought to identify the common elements in the curriculum of six technical training programs. In another study, the researcher (Arnold, 1965) was concerned, among other purposes, with the identification of a core of courses which management agreed desirable for most post-high school technical programs.

Two outstanding studies focused on content analysis. In one (Roney, 1964), mathematics and science content of ECPD accredited curricula in post-high school technician training institutions was analyzed. In another (Barlow and Schill, 1962), the Q-sort technique was employed to identify the essential mathematics content of electrical and electronic technology curricula in California.

The analysis of single industries or single technical fields is still a very common type of action research. Some of these studies related to: the lumber and wood products industries (Stegeman, 1957), agriculture (Technicians in Agriculture, 1962), foundry industry (Bailey, 1964), computers (Matulich, 1964), petrochemical maintenance management (Reach, 1966), and data processing (Business Data Processing -- Technical Courses, 1962).

An outstanding study of the technical skills and knowledges required for highly skilled technicians in 23 selected manufacturing

and processing firms with implications for curriculum development was completed by Merle Bodine (Kansas State Board for Vocational Education, 1959b). Somewhat similar information concerning 65 general and specific job activities found in 85 establishments was contained in a government brochure (U.S. Department of Labor, Bureau of Employment Security, 1961b).

A survey of "need to know" mathematics and science information for the chemical and electronics industries was reported in a California study (Mathematics and Science Competencies for Technicians, 1960).

Content for draftsmen's curricula was the subject of at least two reports. The opinions of graduate engineers on this subject were analyzed in a master's thesis (Pilotte, 1965). "Where Does a Draftsman's Work Stop and an Engineer's Work Begin?" was the topic of a recent paper (Dobrovolny, 1962).

High School Level

National interest has been exhibited in a study of a program designed to meet the needs of the average high school student through the establishment of a pre-technical curriculum in two high schools and Cogswell Polytechnical College (The Richmond Plan, 1963). The plan resulted from the recommendation of study committees and was supported by the Rosenberg Foundation.

A focal point for development of vocational awareness at the secondary level may result from research (Altman, 1966) having as one of its objectives the development and verification of methods for deriving general capabilities from job information. Selected were

occupations with their component jobs and tasks having determined measurable performances. Performance measures were administered to a sample of students followed by determination of the relationships of general capabilities with aptitudes and with educational experiences.

Post-High School Level

A national survey with strong implications for curriculum development at the post-high school level was made by the Technical Institute Division of the American Society for Engineering Education (Henninger, 1959b). Findings include curriculum patterns with a number of typical curricula reproduced in the appendices. Another aid in developing curriculum was the work of two authors (Smith and Lipsett, 1959) which presents a broad overview of curricula and their components. Suggestions for curriculum development in the community college were part of the comprehensive treatment presented by another author (Thornton, 1960). Many practical suggestions and useful approaches to the problem were included in a booklet designed to provide guidelines for the educational administrator concerned with technician training (Emerson, 1962).

Two suggested curricula for educating printing management personnel were a direct outgrowth of the findings of a master's thesis (Gross, 1964).

"Functions of Industry" Research

Two reports of studies reflected the "functions of industry" approach for curriculum framework. One researcher (Duel, 1958) tested such an approach for training electronic technicians, organizing the learning environment around conditions which more nearly simulated

those which are encountered on the job. Another researcher (Stern, 1964) was interested in determining the acceptability of the approach as a curriculum framework for industrial education. A textbook survey followed by two opinionnaires, one to professional management consultants specialized in the area of manufacturing and another to management personnel affiliated with a random sample of manufacturing establishments, constituted the instruments of research. The findings indicated that textbooks, consultants, and management personnel were in substantial agreement with the proposed "functions of industry" approach as a universal framework for understanding the activities of goods-producing industrial establishments.

Guides

A series of suggested guides for the development of two-year post-high school programs have been prepared under sponsorship of the federal government for a number of technical fields. Some of these guides are: Chemical Technology (U.S. Office of Education, 1964a), Electronic Data Processing-I (U.S. Office of Education, 1963a), Electrical Technology (U.S. Office of Education, 1960a), Electronics Technology (U.S. Office of Education, 1965a), Electronic Technology (U.S. Office of Education, 1960b), Instrumentation Technology (U.S. Office of Education, 1964b), Mechanical Technology (U.S. Office of Education, 1964c), and Metallurgical Technology (U.S. Office of Education, 1965b). Other such guides intended for aids in developing technical curricula of shorter duration include: Course in Instrument Maintenance (U.S. Office of Education, 1963b), Highway Engineering Aide (U.S. Office of Education, 1964d), and Organizing a Dental Assistant Training Program (U.S. Office of Education, 1965c).

Two aids provided job descriptions and suggested techniques for determining courses of study designed to help prepare programs under Title VIII of the National Defense Education Act. They are Electronic Data Processing in Engineering, Science, and Business (U.S. Office of Education, 1965d), and Mechanical Drafting and Design Technology (U.S. Office of Education, 1964e).

Several states and local educational units have followed the lead of the U.S. Office of Education in developing suggested curriculum guides. A suggested guide for data processing (Washington State Board for Vocational Education, 1963) has been prepared by one state while another state has developed a guide for drafting and design technology (Mississippi Curriculum Laboratory, 1965). At least three states have developed guides for electronics technology (Mississippi Curriculum Laboratory, 1964; Illinois Engineering Technology Curriculum Committee, 1964; Florida State Advisory Committee for Technical Education, 1962). The State of Washington developed a guide for engineering technology (Binnie, 1964), while one of its colleges (Lower Columbia Junior College, 1961) produced a guide for a forest products technical education program. A guide for a curriculum leading to an Associate of Science Degree in law enforcement was developed in Oregon (Oregon State Department of Education, 1964). Another state developed a guide for machine design technology (Illinois Curriculum Advisory Committee, 1963). A guide for mechanical technology was prepared as a result of a state workshop (Mississippi Curriculum Laboratory, 1966). PERT was the topic of a recent curriculum aid developed under the State Board for Vocational Education in the State of Washington (Hitchcock, 1964).

A recent survey by the Chattanooga Chamber of Commerce resulted in significant information for curriculum development (Chattanooga Public Schools, 1961).

Public information relative to technician curricula with a discussion of a number of patterns of curricula has been produced by at least one state (Michigan State Department of Public Instruction, 1959). In another state, the story of data processing training was excellently presented in brochure form (McKee, 1963).

Other Curricula Information

Industries' role in curriculum development was reported in three digests (Florida Division of Vocational and Adult Education, 1959: Proceedings of National Conference on Manpower Training and Development for the Watchmaking and Precision Industries, 1964: Illinois Board of Vocational Education, 1966).

Characteristics of industrial-technical education curricula in the public community junior colleges of Michigan was a topic of an extensive doctoral study (Larson, 1965b).

Description of the curriculum in industrial instrument technology with discussion of plant, equipment, and initial costs at Del Mar Technical Institute were outlined in a recent article (T. Boaz, 1959).

The four options of the ECPD accredited curriculum in civil technology at Oregon Technical Institute were well described in an article in School Shop (Brookins, 1959).

An excellent source of information for curriculum development and program planning was a comprehensive and intensive survey of

industries and schools in San Fernando Valley, California (Dauwalder, 1961).

## EDUCATIONAL PROGRAMS

While treatment of technical education programs are part of several textbooks and references, the amount of research reported in this field is very limited. The significance of this field suggests the need for additional research and the possibility of resulting innovations producing an impact of great value for large numbers of individuals in and out of technical education.

Accounts of the status of technical education programs were described in three public documents. One document (Federal Security Agency, 1944) provided an extensive overview of various types of vocational-technical programs in high school and post-high school institutions. Another report (President's Committee on Education Beyond the High School, 1957) concentrated mainly on occupational education programs in the community junior colleges. A classic approach to the scope and level of technical education programs was closely coupled with the role of institutions in a bulletin prepared by Dr. Lynn Emerson (U.S. Office of Education, 1958).

Five research studies were reviewed that have significant implications for technical education programs. In one study (California State Department of Education, 1959), the contributions of the junior colleges of the state over a 10-year period were carefully reviewed and positive recommendations for future action made. Two state studies focused on the programs of technical education as applied in all public institutions operated within the state (Pearce, 1964;

Florida State Department of Education, 1965). A survey of the rapidly growing concept of work-study programs in junior colleges (Barlow, 1963) and the concept of the four-year technology programs (H. E. Boaz, 1965) suggest movements which may become trends in the near future. A systems approach to updating teachers in their technology to keep pace with new innovations in industry, technology, and science was the subject of the research project entitled "A Vocational-Technical Teacher Technology Center -- The Development of a Model" (Larson, 1966).

A detailed report of the activities in training for jobs of unemployed and underemployed with resultant implications for MDTA and other programs was provided in addition to resumes of research supported by The Department (U.S. Department of Labor, 1964). An excellent description was given of the programs provided under the first year's operation of the MDTA (U.S. Department of Labor, 1963).

The procedure for planning technical education programs was described in a brochure prepared by the State of Florida (Florida State Department of Education, 1958).

Individuals and groups seeking assistance from the current literature in research related activities and in planning for high school and post-high school programs of technical education will find some needed assistance in several references (Henninger, 1959b: Medsker, 1960; Emerson, 1962; Education for a Changing World of Work, 1963; Technical Training in the United States; Appendix I to Education for a Changing World of Work, 1963; Technician Education Yearbook, 1963; Technician Education Yearbook, 1965; Venn, 1964).

## INSTRUCTIONAL MATERIALS AND DEVICES

Very little research was in evidence on this subject. If research, to a significant extent, is being done on the subject for technical education, it was not released to the author or to the public libraries utilized by the author. It may very well be that the nature of the subject is such that research and writings on this subject are general rather than focused from the point of view of technical education.

Two research studies were conducted in a technical education setting using recent innovations in teaching. In one instance, the researcher (Stout, 1963) designed a study to measure the effectiveness of television as a method of teaching selected subjects in electronics technology programs. Phase I (Pilot Study) was considered a period of experimentation with the television system. Phase II provided a complete and detailed analysis of a television system feasible for operation in a local school system or in another technical institute. Another researcher (Rothschild, 1966) built and tested experimentally the educational effectiveness of a forced-response device for group instruction. Using an experimental and control group with 28 students in two groups with alternate groupings, the researcher found somewhat superior learning resulted for the group using the forced-response device.

Two other studies related to teaching machines have implications for technical education (Fine, 1962; Fry, 1963). However, neither study was oriented particularly to technical education. A report of an institute on programed instruction in industry and

education revealed many facets of this new and exciting movement (Teal, 1963).

In another interesting article, a critical evaluation was made of multimedia rear-screen projection in educational presentations (Wyman, 1966). In a brochure, descriptive of low-cost fabricated three-dimensional teaching aids for trade and industrial education, much information was given which is important for technical education (U.S. Office of Education, 1961b).

## LEARNING PROCESSES AND TEACHING METHODS

The literature of technical education research is sadly lacking in reported research in this very important division. With the extension of technical education to larger numbers of high school and post-high school institutions serving more students than ever before, this is a challenging field for research. The changing concept of the scope of technical education in ever-broadening spectrums to widening ability levels offers rich and fertile opportunities for more and better information concerning learning processes and teaching methods uniquely designed to meet the challenges of expanded horizons of technical education.

In a bulletin, the U.S. Office of Education covered cooperative programs in the U.S. at the technical institute level (Armsby, 1954). Another author (Morecock, 1953) described the organization and operation of a cooperative education curriculum in electrical technology at Rochester Institute of Technology. The vital problems encountered in operating a cooperative engineering educational program were discussed in detail in an article, "Cooperative Work-Study Programs" (Huddleston, 1958).

## STUDENT PERSONNEL SERVICES

A number of studies have been made relative to the success or failures of graduates and the opinions of graduates and former students of the educational programs and services provided.

An outstanding study on a very difficult but timely subject was recently completed concerning the relative importance of job-related motivational forces among disadvantaged workers (Champagne, 1966). Trainees in the federally-supported program, Special Training for Economic Progress (STEP), were studied. Some of these students were preparing to enter technical fields. Two instruments were designed to assess the relative strengths of factors of job satisfaction and to measure the levels of attitudes following rigorous psychometric procedures. A detailed personal history questionnaire was also employed. Findings of this study indicated that the underprivileged workers have a high need to prove their value to society.

### Follow-Up Studies

Some findings and implications for technical education were contained in a recently completed nation-wide study supported by the Ford Foundation (Eninger, 1965) using a randomly-selected sample from 10,000 male high school graduates of the years 1953, 1958, and 1962. The study indicated additional training needs of groups of graduates such as electronic technicians.

In a regional study of 13 states (North Atlantic Region, 1965), the growth of technical education in numbers of students and numbers of curricula were included in the findings. This study employed a 100 per cent sample of the 1963 high school graduates.

Insight into the characteristics of technical institute students is provided in two other significant studies (Miller, 1966; Righthand, 1965).

In at least six state and area studies, efforts were made to follow up graduates and former students. Two studies were made of technical education in community colleges. One researcher (Larson, 1965b) studied all students who initially enrolled in industrial-technical curricula during the year 1958-59 in eight community junior colleges of Michigan. Another study (Harris and Yencso, 1965) sought to determine whether the educational programs in high schools and community colleges of Michigan were adequate to prepare technicians for employment in industry. Graduates of Georgia's Area Vocational-Technical Schools were studied from the point of view of job placement, job satisfaction, earnings, and related student personnel information (Bottoms, 1965b). An extensive 10-year follow-up study of graduates of Middlesex County Vocation and Technical High School (Coe and Zanzalari, 1964) included data collected from 917 respondents by a questionnaire process. Some characteristics of engineering technical students were identified in a study of a large city junior college district in California (Los Angeles City School District, 1962).

Information concerning the factors that tended to promote success in graduates of mechanical drafting was the objective of a study made for a trade and technical institute (Gahn, 1965).

A recent comprehensive release of the U.S. Office of Education (Division of Vocational and Technical Education, 1965b) supplied vital data concerning numbers of students, programs, and institutions participating in technical education.

Student Selection

Student selection was considered very important together with the role of the counselor and teacher in developing pre-technical programs for average high school students as reported in a recent study (The Richmond Plan, 1963). Scholastic achievement and formal education, together with special aptitude, were identified as the most useful criteria for the selection of students for technical curricula, according to the findings of a doctoral dissertation (Wold, 1961). The researcher used the returns of 169 responses of representatives of public and private schools throughout the United States as a basis for this finding.

Testing as a selection criteria was discussed in two articles devoted to technical education. In one (Helmick, 1958), the importance of standardized tests was discussed; while in another (Case, 1958), tailor-made aptitude and achievement tests as well as standardized tests for selection of students in technical education programs were considered.

Guidance Information for Students

Many brochures and other releases provided guidance information for students. Several were reviewed that were effective sources of guidance information (McDaniel, 1962; Mohs, 1962; Facing Facts About the Two-Year College, 1964; Job Guide for Young Workers, 1964; Occupational Outlook Handbook, 1963; New York State Department of Education, 1959; Washington State Board for Vocational Education, 1961).

Counselor's Handbook

At least two educational units developed guidelines for counselors in vocational-technical schools. One, a state bulletin (Hogard, ____),[1] stressed the need of school counselors working more closely with their local administrators and also outlined the qualifications, duties, and activities of the counselors. An Area Vocational-Technical School Guide (Bottoms, 1965a) provided data that will enable the counselor to use the Dailey Vocational Test scores in relating student abilities to success in school.

General Guidance Information for Technical Personnel

General guidance information for technical personnel is provided in a number of excellent resource books (National Manpower Council, 1954; Smith and Lipsett, 1959; Thornton, 1960; Education for a Changing World of Work, 1963; Harris, 1964).

## FACILITIES AND EQUIPMENT

The increasing needs of larger numbers of students for technical education demand large capital expenditures in physical plant and equipment. Much additional research in this field would be helpful to those individuals who are involved in the planning process. Little research is available directly related to technical education plant and equipment.

Needs

A recent federal report (Division of Vocational and Technical Education, 1965), indicated that at least 125 new vocational-technical

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[1]Date not given.

schools were under construction with 209 additional institutions in the planning stage. A review of the state-by-state reports revealed a rapid rate of expansion and improvement of facilities as a direct result of the Vocational Education Act of 1963.

An extensive state-wide study of vocational-technical education (Florida State Department of Education, 1965) suggested that consideration be given to the use of a standard building components system for construction of laboratory and shop facilities. It emphasized the importance of replacing temporary facilities.

Facilities planned for comprehensive secondary school pre-technical programs should have the quality and atmosphere of a modern industrial research and development center according to the findings of a study by Educational Facilities Laboratories (Implications of the Richmond Plan, 1965). The purpose of this study was to consolidate the experiences and implications derived from the Richmond Plan into a recommended approach for physical facilities in a comprehensive secondary school program. The report further stated that equipment and furnishings should be of industrial quality.

The development of a vocational-technical teacher technology center model was the purpose of a research project supported by the U.S. Office of Education (Larson, 1966). The goal of such a center was conceived as updating vocational-technical teachers in their technology. Working through a panel of consultants, with representatives from all fields of vocational-technical education assisted by architects and specialists in construction and media, educational specifications and preliminary architectural design was developed.

Planning and Design

Many states have guides and aids dealing with the planning and construction of educational facilities. Most of these relate either to the general problem or to the broader needs of vocational education and industrial arts; little specific information for technical education was identified.

A recent federal publication provided an excellent outline of considerations in planning vocational and technical education facilities (Chase, Browne, and Russo, 1965). Covered are topics such as surveying needs, educational specifications, general planning suggestions, construction costs, and capital outlay.

Some assistance was available through planning guides developed by some of the individual states, even though the focus often was not specifically on technical education (Greiber, 1964; Michigan Department of Public Instruction, 1964; New Jersey State Board of Education, 1964).

A volume of material on planning and equipping the school shop was developed by Prakken Publications (Modern School Shop Planning, 1965).

Two very helpful aids in the planning process of such facilities were the result of recent research. One, based on research by John Y. Jamrich of Michigan State University (Weinstock, 1964), described the planning process, utilization of instructional space, and improvement of over-all facility utilization. An outstanding workbook for determining space utilization has been incorporated into this publication. Another researcher (Merlo, 1964) concentrated on the basic factors necessary for planning comprehensive community college facilities.

A guide was developed utilizing such individuals as chief state school officers, members of professional organizations, community college specialists in college facilities, and specialists in the U.S. Office of Education and American Association of Junior Colleges. A checklist of more than 300 questions concerning community college facilities was devised from the results of the study.

A report (New Building on Campus, 1963) presented graphic interpretations by six architectural firms of the design for an instructional research and communications center which has several implications for planners of technical education facilities. Another report provided excellent information for such planners illustrating the design and construction of a modern, functional science and technology building (Miami-Dade Junior College, 1965).

Ten months of research on the subject of designing schools for educational television resulted in much information important to technical education (Chapman, 1960). This report strongly presented the concept that the design of the school, its spaces, and its facilities must not only permit but should strongly support the educational functions.

An article (Allee, 1959) which contained many ideas relative to buildings and facilities in general provided some suggestions for individuals involved in planning new facilities or altering present structures used in technical education programs.

Two other sources of excellent information on costs and economy in planning and construction of facilities should be studied prior to building facilities (National Council on Schoolhouse Construction, 1961; Educational Facilities Laboratories, 1964).

## TEACHER EDUCATION

The role of the teacher and teacher educator was the subject of several research studies. In an early study the role of the departmental chairman in industrial teacher education was viewed from the point of view of preparation, experience, activities, and working conditions (Minelli, 1958). In this doctoral study a questionnaire check sheet was used to obtain information from 123 chairmen of such departments.

In order to strengthen teacher preparation in the subject-matter area of the electrical field, a researcher (Jelden, 1960) compared the basic informational content of textbooks and other instructional materials used in electrical courses offered to industrial education majors in teacher-education institutions with the basic electrical knowledge required of persons who work with electronic devices in industry. Two questionnaire forms were developed, one for heads of departments and another for instructors of electrical subjects, in order to identify the instructional materials used and other important data. The analysis of the content of the instructional materials was then sent to 22 selected electronics manufacturing industries to be rated as important for electronic technicians.

The occupational self-image of teachers was explored in another study by a doctoral candidate (Nelson, 1962). The investigator employed Dr. Robert Dubin's "central life interest" inventory in addition to one developed to measure the major work-role in industry of 230 selected teachers. In another study several unique aspects of technical teacher characteristics with implications for teacher recruitment and training were revealed (Cotrell, 1960).

Three studies were concerned with inservice teacher education. One of these (Brantner, 1964) was mainly concerned with the inservice education activities in which the technical and industrial teachers had participated and desired to participate. A check-list opinionnaire was the instrument used. A recommendation of the study called for increased inservice education activities in both the professional and subject-matter categories.

In another study (Silvius, 1965) of the practices and policies essential to keeping industrial education teachers of Michigan qualified, 56 persons were selected to react to issues formulated from a number of pertinent factors. Out of this study developed eight specific proposals for action programs or additional research studies representing the areas of greatest concern to both the interviewees and the staff of the study.

A summer inservice pilot program for teachers involved with instrumentation of a technical nature was supported by a grant from the U.S. Office of Education (Larson, 1965a). Every student indicated a desire for such continued inservice activities.

A research activity (Minelli, 1965) encompassing a three-fold plan of involvement of the university, the community colleges, and the high schools with industrial firms in a partnership relationship to strengthen teacher preparation was recently supported by an extensive grant of the Ford Foundation. The program still in progress represents a realistic approach to teacher education.

A study (Larson, 1965b) of the preparation of 138 teachers in industrial-technical programs in community junior colleges of Michigan

established profiles of preparation in subject-matter areas and pedagogy as well as actual years of teaching experience and closely related industrial experience.

In two recent papers, qualifications of teachers of technical subjects were carefully analyzed. The first paper (Dobrovolny, 1963) identified the requirements for a faculty member essential to a quality program in technical education. The second paper (Dobrovolny, 1965) identified the essential preparation of technical teachers.

The role of colleges and universities in the preparation of teachers of technical education subjects was mentioned in several instances in the challenging report by the American Council on Education (Venn, 1964). The thesis of this report has been ably presented as technology creating a new relationship between man, his education, and his work, in which education is placed squarely between man and his work. With education in such a position, the role of the teacher and teacher educator is paramount.

## ADMINISTRATION AND SUPERVISION

The potential for additional research in this field is great. Some significant studies in specialized sectors of the field have been made. It would seem highly desirable to encourage further extensive research in technical educational administration and supervision.

A major break-through in stepped-up effective planning for new institutions in technical education occurred with the report of the use of "PERT" as a planning tool (McKee, 1966). The nine steps in the establishment of a two-year technical college were determined and some 300 events accomplished in 88 days. The administration used a "team

approach" whereby the three main administrators focused attention on a major activity, planned and started its evolution, assigned it to a staff member for completion, and then initiated the next activity. This project was supported by the U.S. Office of Education.

A published doctoral dissertation (Burns, 1964) resulted from an investigation of the factors governing the establishment and operation of area vocational-technical schools and programs in the United States. Several guidelines for administrators were contained in the findings, relating to such matters as size of area school district, population base, industrial support, and similar subjects.

In a series of studies at the University of Michigan, major attention was devoted to administrative aspects. In one study (Wenrich, 1962), more effective ways of using state and federal funds were explored. A second study (Wenrich and Ollenburger, 1963) focused on how high school principals perceived that programs for employment-bound youth could be more adequately developed through greater outside assistance. A third study (Wenrich and Van Dyke, 1963) explored the attitudes of local administrators regarding the financing of vocational education in Michigan. The pattern of organization for effective vocational education in Michigan was the subject of another research activity (Mason, 1963). The researcher used two groups of schools, one considered to be above average and the other below average, and developed a questionnaire to determine who within a particular school had the initial responsibility for the performance of selected administrative functions. Another study (Wenrich and Hodges, 1966) reported details of the first University of Michigan Leadership Development Project for Vocational and Technical Education

with results of the subsequent follow-up study of 40 participants included.

In the brochure, "Area Vocational Programs" (U.S. Office of Education, 1960c), the framework for the administration of technical education under Title VIII of the National Defense Education Act of 1958 was discussed.

Several states have issued documents stating recommended practices for the administration and supervision of technical education programs. Especially helpful among these releases are those relating to organization and finance (Wisconsin State Board of Vocational and Adult Education, 1966; Greiber, 1963; Michigan Division of Vocational Education, 1966; Oregon State Department of Education, 1966; California State Department of Education, 1966).

Several suggestions and aids for supervisors and administrators of programs of technical education are provided in a recent handbook (Izzo, Munson, and Sword, 1963).

## EVALUATION

One of the most frequently used studies for evaluation of technical education is the McGraw Report, "Characteristics of Excellence in Engineering Technology Education" (The American Society for Engineering Education, 1962). The report followed a year-long study by a committee concerned with the development of guidelines for constructing, improving, and evaluating technical education of this level.

A guide for institutions in a self-examination of its goals and the educational activities which it has in operation to accomplish them has been developed by the Department of Community Colleges in North Carolina (Manual for Institutional Self-Study, 1965).

A 15-month research project established by the American Vocational Association and supported by the Division of Cooperative Research of the U.S. Office of Education was designed to identify and describe--through a nation-wide survey of selected schools, including technical and vocational-technical schools--the vocationally talented students. This evaluation described the curricula and programs in a number of technical schools and summarized the progress made in the various states in technical education.

In a questionnaire study by the Curriculum Commission of the American Association of Junior Colleges (Dwyer, 1960), the findings of the study related general education to technical and vocational education.

An evaluation of the vocational education program in South Carolina (Flesher, 1963) recommended expansion of vocational and technical education facilities to meet the needs, even though at present it indicated substantial growth in school population in this field.

Evaluation of a special MDTA program for disadvantaged persons, called the Norfolk Project (Office of Manpower, Automation and Training, 1965a), revealed that as a result of the MDTA education a great improvement in attitude as well as a high placement record was achieved. Eighty-nine per cent were employed one year after graduation.

An assessment of vocational and technical education in the secondary schools, on a basis of random selection of youth in selected institutions by questionnaires, was coupled with supervisors' ratings and the opinion of an independent jury of experts in a well-designed

statistical study (Kaufman and Schaefer, 1965). The study sampled attitudes, opinions, and occupational activities of the graduates constituting the sample.

What happens to graduates of four-year technical state college programs who do not become teachers? This question became the subject of a doctoral dissertation completed at the University of Missouri (Robinson, 1965). In a study of 508 non-teaching graduates from Southwest Missouri State College who received baccalaureate degrees during the years 1960 through 1964, 53.3 per cent were employed in occupations directly related to the technical knowledge and skill of their major in college.

A paper prepared for a conference sponsored by The Center for Studies in Vocational and Technical Education of the University of Wisconsin (Corazzini, 1966) attempted to answer the question, "When should vocational training begin?" The speaker presented cost figures of vocational education at the high school level and technical education at the post-high school level. He said that post-high school graduates enrolled in technician curricula would incur costs of $2,544 per year but would have an annual salary of about $400 more each year than the vocational school graduate.

There are several other considerations, psychological and social as well as economic, involved in the solution to this problem.

A comprehensive evaluation of vocational education (including technical education) was given in a report of the Michigan Vocational Evaluation Project (Borosage, 1963).

The State of Kansas made a thorough study of the role, function, organization, general supervision and financing of junior colleges as

part of a total program of evaluation (Advisory Committee on Junior Colleges, 1964).

A questionnaire study (Formal Occupational Training of Adult Workers, 1964) planned by the Bureau of Labor Statistics focused on the evaluation of vocational training background of workers between the ages of 22 and 64 years who had completed less than three years of college. This study covered 50 states with approximately a 73 per cent response of the 35,000 sample.

## RESEARCH

Research has been a significant instrumentality of technical education only since World War II. A detailed outline of procedures used in several occupational surveys was included in the book, Terminal Education in the Junior College (Ward, 1947).

A study made to develop a research design which could be used to investigate the work functions and understandings of industrial technicians was developed at Michigan State University (Brandon, 1960). This report described the research procedures used. A similar objective motivated a research study (Jocoby and others, 1960) at Pennsylvania State Department of Public Instruction. The goal of the study was to develop more efficient and uniform survey techniques, procedures, and forms to guide the survey specialist in planning, conducting, and reporting the trade and technical education needs and interests of the area.

A project (O'Connor, 1965) of the Student Personnel Commission and the American Association of Junior Colleges was concerned with follow-up studies in junior colleges. The report was presented as

a guide to the philosophy, planning, procedures, and use of follow-up studies.

In 1963, the Ford Foundation initiated an effort to help improve vocational and technical education in the United States. In the brochure, "Ford Foundation Grants in Vocational Education" (Ford Foundation, 1965), a report was given of research grants made since 1963.

A number of research instruments, such as standardized tests, interviews, observational techniques, and questionnaires, were planned for a research activity designed to compare a broad field-oriented approach with one more specifically job-oriented to retrain unemployed workers as mechanical technicians - tool designers (Bjorkquist, 1966).

Summary of funded, completed manpower research projects were provided annually by the Office of Manpower, Automation and Training (Office of Manpower, Automation and Training, 1964; Office of Manpower, Automation and Training, 1965b).

Research contracts entered into by the Secretary of Labor were reported with brief summaries in Part II of the report, "Manpower Research and Training" (U.S. Department of Labor, 1964). The most recent release of this report provided excellent summaries of recent research supported by The Department (U.S. Department of Labor, 1966). Several of these studies identified trends and new developments in technology.

## OTHER

A number of excellent studies, reports, and articles are grouped under this category as these were not suited to the previously identified headings.

Technical Education Need Studies

A large number of studies have been made at the state and local level in order to determine the need for technical education. This category is not the same as Manpower Needs and Employment Opportunities.

Seven state-wide studies were reviewed in which the heavy emphasis was identifying the need for vocational and technical education. Excellent research findings were provided in these studies (McClure, 1960; Pennsylvania Department of Public Instruction, 1960; Flannery, 1961; Watanabe, 1961; Strayer and Kelly, 1962; Employment Security Commission of North Carolina, 1962a; Minnesota State Department of Education, 1964; New Jersey State Department of Education, 1964b).

Illustrative of the technician need studies reviewed at the local level were sixteen studies (Campbell, 1964; Lang and others, 1960; New York State Department of Education, 1963; Kidd and Sutker, 1960; Pasadena City Schools, 1961; Coe and others, 1960; Donaghay, 1959; New Jersey State Department of Education, 1960; New Jersey State Department of Education, 1963; Kulp, 1963; Kleinman, 1965; University of Michigan, 1963; Lombardi, 1962; Murphy, 1964; Hodgson, 1965; Dauwalder, 1961).

In a few cases the studies were oriented in the direction of a particular field such as electronics. Most of these were local or area studies, but one was a state study (Schweitzer, 1964; Buller, 1961; Carlson and Lepak, 1963; Phills et al., 1964; Howell, 1965; Technical Education Needs of Persons Engaged in Agricultural Occupations, 1965).

A study was made to determine what students should take in high school in order to best prepare for entrance into junior college electronic data processing programs (Chapin, 1962).

The Monthly Labor Review contained the report of a survey conducted by the Bureau of Labor Statistics to determine the education and training needs of technicians (Stambler and Lefkowitz, 1964).

State-Wide Plan

Three studies provided information of efforts directed toward the concept of state-wide plans for technical and vocational education. An outstanding study with very realistic recommendations resulted from such a research project for the State of Maine (Flesher, 1962). In another study sponsored by the W. E. Upjohn Institute for Employment Research, the role of the community college in technical education was stressed (H. T. Smith, 1963).

Technical education was combined with an overview of all higher education in a state master plan resulting from the action of the Coordinating Committee for Higher Education created by the Legislature of Wisconsin (A Comprehensive Plan for Higher Education in Wisconsin, 1965).

Accreditation and Certification

Helpful in understanding the role of the American Society for Engineering Education and the Engineering Council for Professional Development are two articles recently published (Wenninger, 1964; Werwath, 1964).

The inception, founding, objectives, administrative procedures, and evolution of the American Society of Certified Engineering

Technicians (ACCET) were ably discussed in a paper presented at the World Congress on Engineering Education in Chicago, 1965 (Silva, 1965).

Information Sources

Helpful to researchers and others studying technical education are directories and bibliographies.

An extensive directory of schools offering technical education programs under Title VIII of the National Defense Education Act of 1958 is available (U.S. Office of Education, 1965c).

A carefully organized list of instructional materials in the fields of technical, industrial, and trade education suggested text books and library books for technical education (Washington State Board for Vocational Education, 1965).

An extensive bibliography, "Sociological Studies of Occupations," listed several entries of significance to researchers and educators in the field of technical education (Office of Manpower, Automation and Training, 1965c).

General Information

Much research-type information was contained in a number of releases indicative of the present status and future trends in technical education. Much information was given in the summary compiled from state reports concerning enrollments, expenditures, and similar items as released by the federal government (U.S. Office of Education, 1963).

In a study designed to provide information on the current direction of technological change by reviewing trends in 36 major American industries, much knowledge of changing processes, materials,

equipment, and products significant to technical education was given (Technological Trends in 36 Major American Industries, 1964).

Further insights into changing concepts for technical education were provided by reports of two conferences (Evans, 1962; California Department of Education, 1965).

The duties, skills, and knowledges required of technicians in industry were discussed very effectively in two articles (Bergen, 1959; Bureau of Employment Security, 1961b).

While advisory committees for technical education were not covered in any of the literature reviewed, the federal bulletin, "Organization and Effective Use of Advisory Committees," has many implications for technical education (U.S. Office of Education, 1961a).

An excellent guide for establishing a comprehensive community college was developed for North Carolina (State Board of Education, 1963a).

A report, "Careers for Women as Technicians," contained materials related to the expanding opportunities for training and employment of women in the technical fields (Women's Bureau, 1962).

Another report relating to leadership developmental activities for technical educators through a summer institute was described in a report from Oklahoma State University (Dunn, 1965).

A status report of technical and trade education in secondary schools and retraining programs in Pennsylvania was helpful in understanding opportunities available for technical education in that state (Pennsylvania State Department of Education, 1963).

Typical of several brochures designed to provide public relations information coupled with basic concepts of technical education were two from California (California State Department of Education, 1963; W. P. Smith, 1964b).

## CONCLUSIONS AND RECOMMENDATIONS

While it is encouraging to note that several studies have been completed in a number of areas of technical education, it is rather discouraging to find so little evidence of real research in other areas vital to technical education.

It is to be assumed, however, that the recent additional emphasis on research resulting from the Vocational Education Act of 1963 will produce definite improvements as to both the quality and quantity of research.

Much of the research reported is "action-type" research. But often the researcher moved ahead without carefully evaluating the research design and methodology. In several cases the report of the research did not contain sufficient information to properly evaluate the findings in a structure of good research design.

Large numbers of research studies took the form of questionnaires or opinionnaires. Insufficient attention was often given to delineation of the specific population or the determination of an adequate sample size. While the percentage of return was usually given, little indication was presented of efforts to establish the effect of the non-respondents upon the data accumulated. Indicators of validity or reliability of instruments used were frequently omitted. Interpretations of the findings in most cases were so limited that ability to generalize to a larger population was impossible.

Use of the experimental method was practically nonexistent. Still, the experimental method is the most scientifically sophisticated research method. Technical education bordering on the realm of science is a field in which, hopefully, much more experimental research will be completed.

While several studies have been made in the fields of "Manpower Needs and Employment Opportunities" and "Curriculum Development," other highly significant fields have been practically ignored. The need is great for additional research of high quality in such fields as:

Instructional Materials and Devices

Learning Processes and Teaching Methods

Facilities and Equipment

Teacher Education

Administration and Supervision

Research

If technical education is to meet the needs of students and employers, more organized, meaningful research is essential. More educators and others must be cognizant of good research design and methodology. The functioning tools of research must be a part of the background of all technical educators. Time and motivation to do research are basic to an expanded effort in this or any other field. If educators are to contribute to the field of research on an after-hours basis while attempting to continue "business-as-usual," there is little hope of filling the voids in our knowledge through research.

A unified, organized approach to research in technical education is essential if the necessary impact is to be made! Technical education must develop the same type of philosophy toward research which is now prevalent in the research installation of a modern, major industrial enterprise. Facilities, "tools of research," and adequate support personnel must be provided, plus additional financial support, if research in technical education is to really provide the vital and much needed stimulant to meet the needs of the "front ranks" on the battle-line of quality and quantity in technical education.

The "state of the arts" of research in technical education will be greatly enhanced through an improved system of dissemination of research. At the present time, the difficulty encountered in securing documentation of the achievements of others often discourages use of research information. Many seem hesitant to share the "efforts of their labor."

Really, technical education and research in technical education are just emerging from infancy and growing toward adolescence. Nurture, now, through federal and foundations' support are increasingly essential to provide the firm foundation of a well developed and enduring research effort. Now is the time for a united and an extended effort to help technical education meet the needs of people, youths, and adults, and also to satisfy the basic requirements of the employers of technicians and technically-oriented personnel in all fields of endeavor!

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